

OBSERVATIONS ON THE LIFE HISTORY OF A NEW SPECIES OF PSYCHODA.*

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During the first three weeks of October, 1912, while engaged in certain biological investigations at the Chicago Sewage Testing Station, the writer's attention was attracted to a little white moth-like fly which occurred in great abundance in certain of the experimental tanks. An inspection of the form showed that it was one of the Psychodidæ belonging to the genus Psychoda. An examination was made of the rather extensive series of tanks and filters and it was found that these flies were confined to the immediate vicinity of the sprinkling filters and occurred in such great numbers as to indicate that not only were they breeding in or near the filters but that the environment must be a very favorable one. A survey of the animal life of the sludge of the sprinkling filters was being prosecuted at that time and the collections contained large quantities of a dipterous larva which when bred out produced the Psychodid fly. It was a very easy matter to rear this form and all the life history stages were observed. Furthermore collections from the filters often contained all of the life history stages from the egg to the adult.

In attempting to establish the identity of the adult it was found that it does not agree with any of the descriptions given for known species. It belongs to the group including *Ps. schizura* Kincaid, and *Ps. floridica* Haseman, which resemble each other in the mottled black and white character of the wings. However, this species possesses characters which differ distinctly from either of the above mentioned forms. After making careful comparisons with the descriptions of the species of Psychoda, the writer is convinced that this form must be regarded as a new species.

Psychoda albimaculata, n. sp.

Male: Smaller than the female; length of body (exclusive of extended genitalia) about 1.74 mm. Head and thorax yellowish gray, densely clothed with long, erect, mingled black and gray hairs. Abdomen white, covered thickly with erect white hair; very few dark hairs. Brush of gray hair, about one-fourth the length of the abdomen, extending caudad from the dorsal posterior edge of the thorax. Antennæ white;

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length equal to the width of the wings; 14 segments;¹ composed of spherical nodes joined by clear internodes; first segment cylindrical, the second spherical and distinctly larger than any of the other joints, and both the first and second segments with numerous fusiform scales as well as strong hairs; segments three to twelve inclusive with basal nodes and distal slender internodes; nodes with whorls of long white hair directed distad and projecting beyond the node of the adjacent distal segment; internodes clear, nodes slightly yellow; length of the internodes about the same length as the adjacent nodes; segment 13 bilobed, the basal lobe exceeding the other in diameter, separated by a broad shallow constriction, coating of hair similar to that of middle segments; segment 14 small and inconspicuous, about one-fifth the length of segment 13, with a few hairs and usually three or four terminal scales. Wings ovate, rather acutely angulated at tip of median vein, thick coating of hair on upper surface, moderate coating of hair on under surface; average length 2.1 mm., extremes of variation 1.74 to 2.28 mm.; average width 0.85 mm., extremes of variation 0.66 to 1.02 mm.; upper surface with distinctly mottled appearance, due to the presence of alternate patches of white and black erect hair; basal region of wing with black patches on or near veins III₁, III₂, V₃, VII₂; middle region of wing with black patches on or near veins III₁, III₂, III₄, V₁, V₂, VII₂; distinct tufts of black hair at the distal ends of veins III₁, III₂, III₄, V₁, V₂, VII₂; all intermediate spaces on surface between black patches occupied by white hair; rarely a very indistinct black tuft at distal end of V₂ and VII₁; fringe on anterior margin smoky, length about one-fifth the width of wing; posterior fringe smoky, length about one-fourth the width of wing; distinct tuft of long smoky hairs on costal margin at base of wing; hair on ventral surface of wing short, white, and nearly prostrate; cubital furcation nearer base of wing than tip. Legs white with slight tinge of yellow; extremities of distal segments of the tarsi tipped with brown; tibiae and femora with scattering long black hairs, also some short prostrate black hairs intermingled with the white. Abdomen white, thickly clothed with long erect white hairs, originating on the posterior margin of each abdominal segment, thus producing a series of rings of erect hairs; black and gray hairs scanty. Inferior genital appendages of male prominent; length (including basis) 0.64 mm.; basis strongly developed, broad towards caudal extremity, with median conical projection, lateral margins converge towards base; inferior appendage expanding gradually towards basis; somewhat sigmoid in shape; heavy fringe of long white hair on caudal aspect; terminal spinule small, clavate. Superior genital appendages well developed; two segments; a little over one-third the length of the inferior genital appendages, proximal segment a little more strongly developed than the distal; with a few short whitish hairs. Intromittant organ slender.

1. Care must be taken in estimating the number of segments in this species since the thirteenth is of such a nature that an error can easily be made. The antennae should be mounted so that the tip lies exactly in a plane at right angles to the objective of the microscope, otherwise the superimposed curved surfaces of adjacent parts produce appearances which easily lead to error.

Female: More robust than male; body slightly longer, and diameter of abdomen much larger. Head slightly yellowish, thickly set with white and gray hairs. Thorax white, densely clothed with white erect hairs; a few gray hairs present. Abdomen white, clad in white semiprostrate hair. Antennae white; two basal segments slightly yellowish; agree with the male in all other respects. Wings with average length of 2.58 mm., extremes of variation 2.28 to 3.06 mm.; average width 0.98 mm., variation from 0.90 to 1.14 mm.; otherwise like male. Legs with tarsal segments distinctly yellow, extreme tips dark; tibiae and femora white with scattering black hairs, some long and others short. Ventral plate yellow; about as broad as long; emargination almost circular in outline. Ovipositor yellowish; almost straight.

Habitat: Chicago, Illinois. Described from 25 specimens, 10 males and 15 females.

In looking over the literature on *Psychodidae* the writer was surprised to discover how little of it has to do with the life histories of the various species of this family. Forty-four species have been described from North America, and the life histories of only five are known. Kellogg (1901, p. 46) described briefly the life history of *Pericoma californica* Kincaid; Haseman (1907, p. 324) described the stages of *Psychoda floridica* Haseman; Fullaway (1907, p. 386) reported on the immature stages of *Psychoda schizura* Kincaid; and Haseman (1908, p. 274) described the life histories of *Psychoda nocturnal*a Haseman and *Psychoda domestica* Haseman.

THE EGG.

(Fig. 3, Pl. XXXI.)

Eggs were easily obtained by confining females in stender dishes which contained a small quantity of sludge and water from the filter beds. Females were frequently put into the dishes in the evening and by the next morning clusters of eggs had been deposited. They were laid in masses on the bottom or sides of the dish or on fragments of rock which projected from the surface of the mass of sludge. Egg masses deposited in the dishes were never laid in the water, but just above the water and at the edges of moist areas on the bottom. These egg masses contained a varying number of eggs ranging from 20 to over 100. The masses were irregular in shape and the eggs which composed them were deposited in no definite order. They adhered strongly to the glass and were apparently cemented there at the time of oviposition. Under normal conditions the eggs are laid on the surfaces of the filter stone. It is very probable that eggs are not only deposited near the top surface of the

filter but at some depth since larvæ, pupæ, and adults were found two feet below the surface and it was evident that the adults encounter no difficulty in traversing the interstices.

The eggs are oval in shape and the majority show a slight concavity on one side accompanied by a corresponding convexity on the other, thus giving the eggs the appearance of being slightly bent in one plane. Sometimes this concavity is so reduced that this aspect of the egg is almost straight. A large number of eggs were measured, and it was found that they are quite constant in size. The length varied only from 0.32 mm. to 0.34 mm., and the measurements of the greatest diameter showed a variation of only 0.09 to 0.1 mm. The yolk is centrally located and comprises about one-half of the bulk of the egg. It is opaque, granular, and shows a homogeneous distribution in the freshly deposited egg. The substance outside the yolk is transparent and homogeneous. This substance is largely confined to the ends of the egg, and one end usually containing a larger quantity than the other. The outer egg membrane is smooth and transparent.

Development proceeds rather rapidly and in about sixteen hours after oviposition most of the eggs are in an advanced stage of development. Not all of the eggs of a given mass develop at the same rate, but some lag behind and therefore hatch later. The time between the laying and the hatching of the eggs was found to vary from about thirty-four to forty-eight hours.

THE LARVA.

(Fig. 6, Pl. XXXII.)

Larvæ in all stages of development occurred in great abundance in the sprinkling filter beds. The influents of these filters come from the settling and septic tanks and are thrown out into the air in a spray which falls on the surface of the filter bed and filters through about ten feet of crushed limestone. This influent carried considerable solid organic matter in suspension, some of which is retained in the filter. This sludge accumulates in some quantity on the surfaces of the stones and in the interstices formed by them, particularly in the upper part of the bed. The larvæ are found crawling through and over this sludge, and no doubt derive their food from it. Often larvæ may be found completely buried in the sludge with only the posterior breathing tube projecting into the air. They are active in their habits, and their characteristic crawling and wriggling form of locomotion is moderately efficient. They crawl with comparative ease over the surface of the filter rocks and even have the ability to crawl up the side of a glass vessel in which they may be confined.

At the time of hatching the larva is small, measuring only about 0.5 mm. It is whitish in appearance and quite transparent. It is active from the time of the emergence from the egg, and increase in size takes place rapidly. At this stage the two reddish-brown eye spots on the lateral aspect of the head are quite distinct. Immediately after hatching the little larva places itself, if possible, in a position which allows the breathing tube to be exposed to the air.

The mature larva is cylindrical, slender, and from 8.5 mm. to 9.5 mm. long. The greatest diameter, which occurs in the anterior region of the body, is about 1 mm. The color is light brown. In the mid abdominal region a whitish or silvery appearance is common and is in part due to the fact that the longitudinal tracheal trunks show through the integument to some extent. The body is composed of the head, three thoracic segments, and eight abdominal segments.

The head is much smaller than the adjacent thoracic segment. It is smooth, deep brown in color, and strongly chitinated. A pair of oval brown eye spots are present on the anterior lateral aspect. The head is to some extent retractile, and may be partially withdrawn into the thorax. The lateral margins of the clypeus converge posteriorly. Minute antennae appear as a number of tiny rods of similar shape and size. The tip of the labrum is spiny and also bears a few setae. The mouth parts, which are setose and denticulate, are enclosed in a sunken space on the anterior part of the ventral aspect of the head. On either side of the labrum and attached to the ventral surface is a pair of setose segmented appendages which in the living larva are in constant motion being rapidly extended and retracted and apparently serving as prehensile organs. Two pairs of clusters of setae occur laterally, one pair near the eye spots and the other pair nearer the prothoracic segment. Setae also occur on the dorsal aspect of the head, one aggregation located midway between the eye spots, two setae near the middle, and two setae near the caudal margin.

The thoracic segments are distinct and each shows one well marked constriction which divides it into an anterior and a posterior annulus. The posterior annulus of the prothoracic segment bears four groups of setae (usually two in each group), two dorsal and two ventral. The ventral group usually has one long seta. The dorsal surface of the posterior prothoracic annulus bears two small brown protuberances, one on either side and dorso-lateral in position. The tip of each protuberance bears a closed spiracle which is the terminus of a branch of the tracheal system. The mesothorax and metathorax have one constriction each, and in other respects are similar to the prothorax, with the exception that the diameter is slightly increased. The thorax as a whole is smooth, and the fine chitinous surface spines are much smaller than those on the abdominal segments.

The first abdominal segment has one constriction, but the following six have two thus marking off each segment into an anterior, a median, and a posterior annulus. The setae on the first segment are arranged as in the thoracic segments, while in the following segments ventral groups

occur on the anterior and posterior annuli of each. Two groups of setæ occur on the dorsal aspect of each posterior annulus. The entire surface of the first seven abdominal segments, excluding the intersegmental grooves and the constrictions, are thickly studded with fine brown chitinous spines. The eighth, ninth and tenth abdominal segments bear, on the dorsal surface, nine chitinous plates, one on each annulus. These plates are brown, heavily chitinized, and transversely elongated. They are not uniform either in size or shape, but in general the nearer the caudal region the larger do they become. The plates on segments nine and ten are approximately constant in size and shape in the different specimens, but in segment eight there is some variation. Usually three plates are present, but occasionally a specimen is found in which one may be very diminutive, or even entirely lacking. The plate on the posterior annulus shows the greatest variability. In exceptional cases it may be entirely absent, but the common form of the variation is in the size and shape. Judging from the predominance of the specimens showing it, the common form seems to be a central, somewhat quadrate plate with a small circular plate on either side. Other specimens may show the middle plate reduced to the size of the two small lateral ones. Still others show one of the lateral plates apparently fused with the central piece, and finally, specimens were examined in which the lateral plates were absent and the middle plate well developed. It seems probable that the latter has come about by the complete fusion of the two lateral plates to the median.

The terminal (eleventh) segment is smooth, heavily chitinized, and tapers caudad. The tip is emarginated. It bears two dorsal projections which show a few strong bristles; also two ventral projections, longer than the dorsal. Each of the four projections is armed at the extreme end with a crown of strong bristles. The anal opening is on the ventral side of segment eleven and near its base. The opening occurs on an anal papilla which is composed of four lobes. The region immediately surrounding the papilla is not chitinized, but close behind it is a lunate chitinous plate. Several long setæ occur near the papilla.

This larva differs distinctly from that of *Ps. schizura* in length and in diameter, in the number of chitinous plates on the dorsal posterior part of the abdomen, and in the presence of eye spots. It differs from the larva of *Ps. floridica* in the annulation of the body, in the number of setæ present and in the number of dorsal abdominal plates. The larva of *Ps. domestica* differs chiefly in the length and in the number of dorsal thoracic and abdominal plates. The larva of *Ps. nocturnal*a differs principally in the form of the body and the number of dorsal abdominal plates.

THE PUPA.

(Figs. 1, 2, Pl. XXXI.)

The pupa rests on the sides of the filter stones, often completely surrounded by sludge with only the breathing tubes

exposed. It is rather sluggish and moves about slowly from place to place by means of a wriggling movement of the abdomen.

A large number of pupæ were measured and it was found that the average length exclusive of the respiratory tubes was 4.5 mm. The range of variation was from 4.02 mm. to 4.86. The greatest diameter which is in the region of the developing wings had an average length of 0.84 mm., the variation being 0.72 mm. to 0.9 mm. When first transformed the pupa is pale in color like the larva but soon becomes darker.

The head and thorax with their accompanying parts are usually deep brown. The thoracic respiratory tubes (Fig. 9, Pl. XXXII) are long and slender. Measurements show the average length to be 0.58 mm. and the extremes of variation from 0.54 mm. to 0.66 mm. Each consists of two parts, a short, yellow, indistinctly wrinkled, proximal stalk, and a much longer, dark, distal part. The latter has its maximum diameter at the base and tapers gradually towards the tip. Under magnification it shows a large number of fine transverse wrinkles. On the dorsal surface two approximately parallel rows of small clear circular spots extend from the base to the tip and there are aggregated into a small terminal cluster. According to Miall and Walker (1895, p. 146) these spots are the external openings of the large trachea which traverses the organ. Dell (1905, p. 303) however, has shown in *Psychoda sexpunctata*, a European species, that in places the tracheal extension bulges through the wall of the respiratory tube thus giving rise to the clear circular spots.

The abdomen is widest at its junction with the thorax and it gradually tapers caudad. The spines along the lateral margins are moderately developed and each normally ends in a fine stiff hair. The intersegmental grooves are both wide and deep, distinctly marking off the segments. Chitin is minimized in these intersegmental grooves and this accounts for the ability of the abdomen to perform rather active movements. These grooves are also much lighter in color than the contiguous parts thus giving the abdomen a banded appearance. The regions between the intersegmental grooves are strongly chitinized. Each bears an armature of spines on both the dorsal and ventral surfaces. On the former there is a single row of spines on the caudal margin of each segment while on the latter there are two rows on each segment, one near the middle of the segment and composed of large spines only, the other on the caudal margin of the segment and composed of large and small spines. Figures 1 and 2 show the number, comparative sizes, and disposal of these spines on the two surfaces. The examination of a large number of pupæ showed that the size and arrangement of these spines are constant and that there is only a very slight variation in the number, the variation being confined to the small spines. These small spines may be simple or compound (with double tips) and those on a given segment may vary to the amount of one or two in different specimens. The dorsal surface of the base of the last segment bears two simple laterally projecting spines and two similar spines occur on the ventral surface.

The caudal extremity of the last segment is laterally compressed and is equipped with two pairs of spines, one dorsal and the other ventral in position. The former is only moderately developed while the latter is strongly developed. The spines in both pairs diverge caudad and in each pair the component spines are separated by a distinct emargination.

This pupa differs from that of *Ps. schizura* in the length and diameter, in the number of abdominal spines, the character of the intersegmental grooves, and the character of the head region. It differs from the pupa of *Ps. floridica* chiefly in the character of the respiratory tubes and the number and arrangement of the abdominal spines. The pupa of *Ps. nocturnala* differs in the number of rows of spines on the first abdominal segment, and in size. The pupa of *Ps. domestica* differs markedly in the shape of the abdomen, in size and in the character of the abdominal spines.

Studies on the structure and activities of the different stages of this species are now in progress and the results will be published later.

The writer considered it unnecessary to give a complete bibliography of the literature on *Psychodidae*. The following list includes only the papers referred to in the article.

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- Dell, J. A. 1905. Structure and Life History of *Psychoda sexpunctata*. Transactions of the Entomological Society of London, pp. 293-311.
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EXPLANATION OF PLATES.

PLATE XXXI.

Psychoda albimaculata, n. sp.

- Fig. 1. Dorsal view of the pupa.
Fig. 2. Ventral view of pupa.
Fig. 3. Eggs. Drawn shortly after oviposition.
Fig. 4. Basal joints of the antenna. Hairs and scales not shown.
Fig. 5. Distal joints of the antenna. Hairs and scales not shown.

PLATE XXXII.

- Fig. 6. Dorsal view of the mature larva.
Fig. 7. Dorsal view of the male genitalia. Hairs not shown.
Fig. 8. Lateral view of the male genitalia. Hairs not shown.
Fig. 9. Dorsal view of one of the pupal respiratory tubes.
Fig. 10. Ventral plate of the female.
Fig. 11. Ovipositor.